Management Strategy for Acidic Deposition in Western and Northern Canada

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ABSTRACT / The governments of British Columbia, Alberta, Saskatchewan, Manitoba, Northwest Territories, and Canada held joint consultations in 1980 to review the available information on acid rain from Western and Northern Canada. It was concluded that acid rain might become a problem in the future and, hence, a research, monitoring, and management strategy for acidic deposition was needed. An overview of the joint governments' management strategy, organization of research and monitoring programs, and accomplishments to date are discussed in this article.

The national and provincial governments of Canada have a tradition of joint action on environmental issues. The result has been cost-effective research and monitoring programs, and a coordinated approach to problem solving regardless of provincial boundaries. The acidic deposition program is a good example. Before 1980, very little was known about the acid rain issue in western and northern Canada. Precipitation chemistry data from a sparse regional network of federal stations suggested that acidic deposition was not a serious problem, but the serious environmental impacts occurring in eastern Canada and United States provided a strong incentive to develop a better scientific information base. A structured, goal-oriented program was developed to produce the maximum amount of information in a reasonably short-time frame, and to develop management strategies to protect the environment from acid deposition.

During the last two decades, various approaches to environmental protection have been discussed in the literature. A review of this topic is beyond the scope of this article. This report describes the framework and general management approach adopted by the governments so far and provides an indication of future direction on acid deposition. Other agencies in the world responsible for environmental protection may find the approach useful.

KEY WORDS: Acid rain; Acid deposition; sulfate deposition; Western and northern Canada; Management strategy; Atmospheric pollutants

*The authors are members of the Technical Committee for the Long Range Transport of Atmospheric Pollutants (LRTAP)/Acid Deposition in Western and Northern Canada, and represent Alberta and British Columbia, respectively.

The Management Strategy

In Canada, the management of the environment is a shared responsibility between the provincial and federal governments. All provinces are responsible for the management of air quality within their jurisdiction and set standards and guidelines for protecting the environment considering social, economic, and political factors. They recognize the federal government's role and responsibility in the following three areas:

1) Development of national clean air objectives and guidelines for various air pollutants in order to prevent the establishment of pollution "havens" in the country, as well as, provide scientific and other assistance under mutually agreed upon arrangements.
2) Matters relating to transboundary international environmental issues especially Canada–United States issues.
3) Resolution of transboundary interprovincial environmental issues, if the provinces involved are unable to reach an agreement.

Therefore, in recognition of the importance of the acid rain issue, the governments of British Columbia, Alberta, Saskatchewan, Manitoba, the Northwest Territories, and Canada agreed upon the following principles for cooperative action:

- To maintain a high standard of air quality throughout western and northern Canada.
- To protect sensitive areas by controlling emission sources and influencing actions in adjacent provinces.
- To work towards harmonized air quality standards where appropriate.
- To develop an integrated air quality monitoring network.

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- To exchange freely scientific, technical, and monitoring data.
- To cooperate on scientific activities such as the establishment of scientific criteria for sulfate, nitrate, and hydrogen ion target loadings, the monitoring of air quality trends, and the identification of areas sensitivie to pollutant deposition.

The acid deposition management strategy adopted by the governments is to protect the sensitive ecosystems, and has four basic elements:

1) Determining the sensitivity of the western and northern Canadian environment to acid deposition.
2) Establishing target loadings that are suitable for the sensitivity of this environment.
3) Monitoring to ensure compliance with the targets.
4) Establishing emission management plans as necessary.

A coordinated research and monitoring program to address these elements started in 1982 and the accomplishments to date are discussed below.

Sensitivity Maps

Sensitivity maps to acid deposition have been prepared for soils, geology, and aquatic systems, using uniform protocols (Lechner and Howard 1987, Swain 1985, Western Canada LRTAP Coordinating Committee on Surface Water 1982, Western Canada LRTAP Task Group on Soil and Geology Sensitivity Mapping 1982, Western Canada LRTAP Technical Committee 1981, 1982, 1983, 1984, 1985). Significantly, this mapping activity has identified major areas that are highly sensitive to acidic deposition. A total of 47% of the 520 lakes sampled in Saskatchewan, and 20% of the 720 lakes sampled in British Columbia, have been classified as highly sensitive. In Saskatchewan, the highly sensitive lakes are concentrated within the Precambrian Shield in the north, and in British Columbia they occur generally within a zone along the coast. There is, however, no evidence of acidification. Lake alkalinity is less than 2.5 mg/L (50 μeq/L) in only 13 of the lakes sampled in Saskatchewan and six in British Columbia.

Target Loadings

The federal and provincial governments of Canada have accepted the concept of a "target loading," based on sulfates, to control the deposition of acidic pollutants in aquatic ecosystems. A value of 20 kg/ha/yr of wet sulfate was developed for protecting those lakes of eastern Canada having moderate sensitivity to acidic

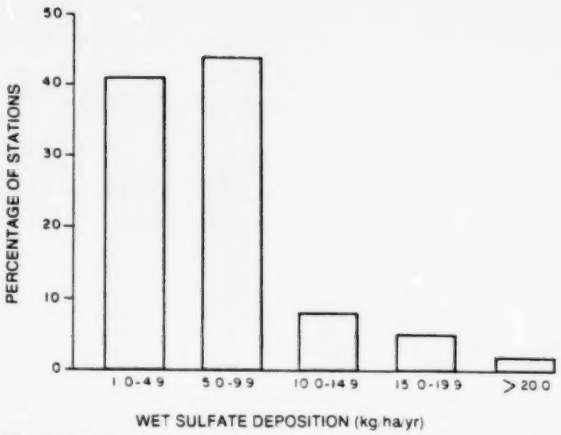

Figure 1. Annual wet sulfate deposition at 39 stations in western and northern Canada.

deposition. This annual deposition would allow pH to remain above 5.3 for all but the most sensitive aquatic ecosystems.

In the application of the target loading concept, it is recognized that it is the total deposition (wet plus dry) that really matters. Since the dry deposition is not readily measurable, the target is expressed in terms of the wet deposition, which is measurable. The wet deposition target loading of 20 kg/ha/yr is site specific to eastern North America and thus is not directly applicable to western Canadian environmental conditions (Sandhu and Blower 1986). Therefore, it is important to establish a suitable target loading for western and northern Canada. This process has been started (Newcombe 1985) and was recently expanded through a contract to the National Research Council of Canada, with a report expected in 1987.

Deposition Monitoring

Uniform methodologies for precipitation monitoring have been documented by McQuaker and others (1983). Precipitation chemistry is now monitored at 62 locations across western and northern Canada. Wet sulfate deposition at most locations is less than 10 kg/ha/yr (Figure 1), and is above 20 kg/ha/yr only at one station (Vancouver). Despite the overwhelming tendency toward low deposition values, approximately 15% of the monitoring stations experience average wet deposition greater than 10 kg/ha/yr.

Dry deposition has not been measured on a systematic basis due to the difficulty of measurement. However, some calculations (Kociuba 1984) indicate that it may range from 3–22 kg/ha/yr of sulfate at locations in Alberta, with an average for the province of 16 kg/ha/yr.

One of the current difficulties in interpreting sulfate deposition data from monitoring stations in dry climates is to account properly for the role of sulfate in windblown dust in the total deposition. In coastal areas some of the deposited sulfate comes from sea salt, but by using sodium chloride concentrations this neutralized sulfate can be calculated and subtracted. Unfortunately, no similar mechanism exists to correct for sulfate from dust.

Emissions Management

Total sulfur dioxide emissions in the four western provinces declined from 1938 kt in 1972 to 1156 kt in 1982 (Table 1), a reduction of approximately 40%. Manitoba currently has an emission ceiling of 738 kt/yr; however, by 1994 the ceiling will be lowered to 500 kt as part of the sulfur dioxide emission reduction program in eastern Canada. Other local control programs may have to be undertaken in this region if monitoring indicates that observed deposition rates exceed an acceptable target loading. Additionally, industrial sources of sulfur dioxide have to be screened for incremental impact.

Transport and deposition models usually will be essential to this process, just as dispersion models are critical to evaluating air quality impacts for common pollutants. Sulfur dioxide and nitrogen dioxide atmospheric emissions inventory methods have been developed (Western Canada LRTAP Air Emission Inventory Working Group 1986). Attempts to use Environment Canada's long-range transport model (Kociuba and others 1984), which was developed and validated for eastern North America, have indicated that it is not well suited for western and northern Canada. Rather, mesoscale models suitable for shorter distances with fewer contributing sources are more appropriate (Western Canada LRTAP Technical Committee and Federal LRTAP Liaison Office 1986, Western Mesoscale Modelling Task Group 1985) and are being actively pursued.

Organization and Agreements

The overall direction and program approval are provided by a Consultative Committee comprised of senior officials of each participating agency (Figure 2). The program is planned and implemented by a Technical Committee of agency representatives. Annual reports have been published since 1981 highlighting individual projects undertaken by governments, industry, and institutions. Ties are maintained with both the national acid rain program and U.S. programs on acidic deposition.

Table 1. Western Canada sulfur dioxide trends (10^3 t/yr).

Province	1972	1976	1978	1982
British Columbia	445	368	231	205
Alberta	807	511	528	488
Saskatchewan	44	41	57	97
Manitoba	642	601	500	366
TOTAL	1938	1521	1316	1156

Regarding the latter, it is noteworthy that in 1985 British Columbia and the state of Washington signed a "Memorandum of Understanding" on acid rain, under which the two jurisdictions agreed to ensure compatibility of data systems, to carry out joint studies and exchange information, and to explore coordinated approaches to the problem.

Concluding Remarks

The participating agencies will have basic information available on three of the four elements of an acid deposition management strategy by the end of the current program in 1988. The sensitivity mapping, deposition target loadings, and current deposition rates will make it possible to activate the management strategy. Full implementation will require further refinements of our current knowledge.

At the present time, the effects of acid deposition on animal and human health are not important issues in western and northern Canada, with the exception of Alberta, where these aspects are being addressed by the Alberta Government/Industry Acid Deposition Research Program. From the national perspective, the acid rain issue is quite different in the eastern and western regions of Canada. Western Canada does not experience high levels of wet sulfate deposition over widespread areas, hence both the science and the control methods must focus on a more localized scale. This difference is reflected in the issues which the western program has carried forward: a uniform protocol for precipitation sampling, regional background deposition levels, mesoscale deposition models, and deposition standards for highly-sensitive ecosystems. Clearly, the issue in western and northern Canada is environmental protection rather than environmental conservation.

Acknowledgments

The authors wish to thank other members of the Technical Committee: Dr. M. Morelli, Manitoba; Mr. L. J. Lechner, Saskatchewan; Mr. M. Smith, Northwest Territories; Mr. D. A. Faulkner, Atmospheric Envi-

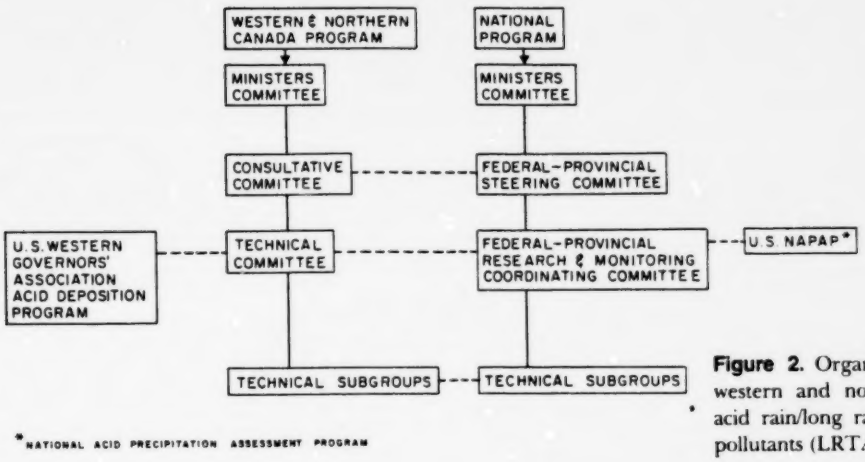

Figure 2. Organization of the national, and western and northern Canada programs for acid rain/long range transport of atmospheric pollutants (LRTAP).

ronment Service, for supplying information and reviewing this paper. The continued encouragement and support of the Consultative and Ministers Committees is greatly appreciated.

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